Appendix 9 – External Reviewer's Report

University of Hawaii – Hilo External Review

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This report on the Computer Science department at the University of Hawaii at Hilo is based on my visit to the department on April 12 and 13, including conversations with faculty members, students, and administrators, and a careful review of the department's self-study. During the visit I spoke in person with the two regular faculty members in residence, most of the instructors and lecturers, the department IT specialist, the divisional chair, the dean, and the Vice-Chancellor. I was also able to speak to two of the other regular faculty who are on leave via phone.

The executive summary is that this is a high achieving department operating on very thin resources. The financial issues facing the department are daunting and require immediate attention, while the retirement of a key faculty member will provide challenges to maintaining the current offerings, especially for non-majors courses. In spite of this the department is providing a very strong and effective program in computer science. The rest of this report addresses these issues in more detail.

Student Views of Computer Science

During my visit to campus I met with roughly 20 students taking the numerical analysis class (a required upper-division course), and 5 or 6 students from a non-major course meeting at the same time. I also examined the results of student and alumni questionnaires as well as the results of the 2017 CERP Data Buddies Department Report for UH-Hilo.

From all these sources, the strong impression that I received was that students felt they were getting a very strong education in Computer Science. A phrase that came up several times in my visit was "rigorous, challenging, and fair". Students and alums feel that they are extremely well prepared for a career in computer science. This is backed up by the results of the MFAT exam given each year, which show the department scores have been consistently above the national institution mean. Moreover the results of the alumni survey show that nearly 98% of the respondents rated the quality of their education as above average to excellent (with 57% rating it excellent!). Student survey results also revealed very high levels of satisfaction with the education in CS: 89% indicating above average to excellent – of whom 67% rated it as excellent – a remarkably high level of satisfaction!

Current students feel very welcome in the department. For example, they feel significantly more like they belong in computing according to the CERP Data Buddies report. According to the same report they are also significantly more satisfied with the computing program than students at similar schools.

Students especially appreciate the lab space provided by the department that allows them congregate and help each other. They also enjoy participating in national and international competitions, events in

which they have been quite successful. Students appreciate the small classes and individual help from faculty, and that the department requirements include a good balance between theory and practice.

The students I talked to had a few mainly minor complaints: lack of funding for hardware/software for individual projects, wanting more experience in using UNIX and command line tools, and wishing for a greater variety of electives. The main substantive complaint that I heard was that different sections of the same required low-level course (e.g., over successive semesters) could sometimes cover very different material. This can be a serious problem because these courses are prerequisites for later courses. We highly recommend that the department meet and specify the contents of the courses that are prerequisites for other courses in the department. Of course individual instructors will need freedom to cover material that they feel is important, but it is quite reasonable to specify core material that every offering must cover. We discuss later some of the curricular changes they requested. While many appreciated the sense of humor of several of the faculty, a few felt that the humor was a bit barbed on occasion.

Budgetary issues

One of the most serious issues in the department is the "B-budget". This budget has been cut by over 70% over the last few years, and is now down to around $8600 per year. These cutbacks are apparently significantly higher than other departments, and are especially troubling given the large number of computers for which the department is responsible. The systems manager seems to be doing a great job of keeping things together with the traditional "spit and bailing wire", including scavenging parts from old broken computers to fix others. It has been the case that occasionally pots of money appear at the end of the fiscal year, but regularly allocations would make it possible for the department to systematically figure out how to replace equipment in the most cost-effective way. Some departmental computers were so old that they could not run the most recent versions of software. This issue is obviously a huge problem for the department and needs to be addressed as soon as possible.

The obvious solution is to increase the budget so that it includes sufficient funds to maintain hardware and software (as well as other normal departmental costs), but I understand there is a severe fiscal squeeze. Here are some suggestions that might help:

1. Lab fees. I heard conflicting information as to whether or not this is allowed at the university. If so, those fees could help pay for hardware and software costs.

2. Microsoft Office licenses: It makes little or no sense for individual departments to pay for Microsoft office licenses when a significantly lower fee can be negotiated for the university as a whole (including student and faculty computers). Most colleges do this (and it is to the advantage of the vendor to have students comfortable with their software). UH-Hilo could save significant funds this way.

Obviously grant funding for these costs would be useful, but few donors want to buy hardware or software licenses for regular course use.

This issue is one of the biggest problems in the department! In the past, the department sold course packets to students and used the profits to support the hardware and software needs. I understand this is no longer allowed, but a replacement source for such funds must be found!

Personnel issues

The computer science department has five tenure track faculty members, one instructor, and several lecturers. The department is currently recruiting a sixth tenure track position for data science. The new position will be welcome and will hopefully drum up interdisciplinary interest in an important subfield not supported well at most undergraduate institutions. The levels of CS expertise vary widely among the lecturers, but they appear to be deployed effectively and provide strong support for non-majors courses as well as some introductory courses in the major.

However, a serious problem is arising in the department because of the retirement of the instructor, Barbara Meguro. Not only has Barbara been teaching many of the sections of the non-majors courses, she has been developing the teaching materials that most of the lecturers use in their courses. She is also managing the (private) internal department website that contains most of the department records and teaching materials.

Replacing her when she leaves this summer should be a very high priority for the department if they are going to continue to provide strong support for non-majors. One of the lecturers will step up into some of her duties, but the department clearly needs someone who can coordinate all of the non-majors courses and the lecturers teaching them to make sure they are fulfilling the needs of the college. In the section on curriculum, we make suggestions about rethinking and revamping some of these courses and their materials, another task that requires a coordinator.

The Computer Science Curriculum

The Computer Science curriculum is strong and provides a strong background in computer science to the majors. However, we have a few recommendations about the rigidity and size of the major. We include a separate discussion of the courses aimed at non-majors and suggest that there be some rethinking of the collection of courses offered.

<u>Major requirement in Computer Science</u>

The course requirements for computer science are among the largest (if not *the* largest) at the college, with 55 credits of CS and 21 credits of math and physics required for the B.S. in CS. While this provides students with a broad and deep education in computer science, I would suggest the department think about either reducing the requirements for the B.S. to numbers more comparable to other majors or to consider introducing a B.A. degree with fewer requirements. (I note that the other campuses of the University of Hawaii do not offer a B.A. degree in CS, so the restrictions on introducing majors offered elsewhere should not apply.). There is tremendous demand in the country (and world) for computer scientists, and most of the positions do not require the full breadth of courses required at Hilo.

Another concern is that the curriculum is quite rigid, with 14 specified 3 credit courses, 1 one credit seminar, plus 3 more courses chosen from 6 options, and then one last free elective. It is almost unheard of for CS departments to require numerical analysis (most CS departments don't even offer such a course) and database internals, for example. Now, there is a strong benefit to having everyone taking the same set of courses: it requires a smaller range of courses to be offered – a not insignificant

benefit to a department with a small number of faculty that requires students to take a large number of classes. There are few classes with small enrollments. Nevertheless, in spite of that benefit, I strongly recommend that the department consider offering students more choice in courses. This has been increasingly the choice in other departments as the number of subfields in computer science has expanded greatly.

The math requirements seem reasonable (though students wish they could take a linear algebra course more aimed at their interests). It might be worth considering whether students could substitute a course in probability and statistics for the linear algebra course, as those topics are increasingly important for courses in machine learning and courses concerned with real systems performance.

The physics requirement is not atypical at computer science departments located in schools of engineering, but is unusual elsewhere. For example, CMU, which is in its own school of computing, does not require physics. A strong argument can be made that computer science is applicable to a broad range of sciences and that a variety of courses can provide the experience with the scientific method. On the flip side, introductory physics courses do not typically provide material required in CS courses (with the exception of digital logic). I suggest considering making physics a prerequisite for any courses for which the material is used, but otherwise allowing students select from a wider range of science courses.

We note that the faculty members seem to be using innovative techniques including a good share of active learning in their pedagogy, to the great benefit of students.

Again, the collection of courses required for the B.S. in Computer Science provides a very strong background for graduates, we only suggest that loosening up these requirements could allow students time to explore other areas of computer science (or indeed other disciplines) that would be of greater value to each student's interests.

Introductory and non-major courses

As mentioned above, the departure of instructor Barbara Meguro will be a great loss for the department. However, it may also be an opportunity to rethink the contents or approaches to the introductory and non-majors courses.

According to reports from some students and instructors, the first two introductory courses (especially the second) can be a great challenge for some students. Here are a few suggestions:

1. Consider changing the language in CS 150, Intro to Computer Science. C++ is a very complex language (likely the most complex of those in common usage). Many departments shifted from C++ to Java in the intro course over the last decade or two, at least partially because it is less complex than C++. More recently many departments have shifted to Python, which is an even simpler language (though it doesn't do a great job of supporting object-oriented programming). One might start with one of these languages in 151, and then transition to C++ in a later required course, e.g., CS 151 or 321.

2.	While there is overhead in making this transition, students can master the basic concepts more rapidly in a simpler language, opening up more space for teaching a second language. Moreover, it is widely agreed that students should see multiple languages in their studies as they will certainly use a variety of languages in their careers both for different kinds of projects and as language technology progresses.

3.	I am pleased to see the offerings of CS 135, 138, and 140 specifically recommended for students wanting some exposure to programming ahead of taking CS 150. The department is currently offering one or more of these each term, which seems appropriate. I do recommend that you add a section to the web and/or catalog making recommendations on intro courses to the catalog or department web site. The parenthetical remarks at the end of each course description will be easily overlooked.

4.	A number of other introductory courses are specifically aimed at non-majors, and at particular at students likely to take only a single CS course. While some are aimed at particular audiences (e.g., CS 132 toward health-oriented majors), others are more general, like game programming, animation programming, etc. I would urge some rethinking and modernizing of CS 100, 101, and 102. A good model would be courses implemented as part of the design of the new AP Computer Science Principles course. Examples include courses developed at Berkeley (Beauty and Joy of Computing) and MIT (Mobile Computer Science Principles). Links to these and others can be found at https://advancesinap.collegeboard.org/stem/computer-science-principles/curricula-pedagogical-support .

	I'm not a big fan of having CS departments offer courses on business tools (e.g., Microsoft Office), as there is not much connection to the core issues of computer science. However, as long as there are adjuncts available to teach the course and there is sufficient demand the only downside would be the confusion between using a computer and packaged software and learning the principles of computing.

Other Issues

ABET accreditation

Some faculty are interested in having the department accredited by ABET. While there is no harm in this, and may in fact be some benefit in highlighting the budgetary issues in the department, accreditation is expensive and the money would be better spent solving some of the issues with funding for software licenses and computer upgrades.

Lab facilities

Aside from the severe budgetary issues referred to above that have impacted hardware and software, the physical spaces used by the department seem to work well. I was particularly impressed by the flexible desks in College Hall 7 that allow students to listen to a traditional lecture and then quickly shift to a configuration supporting collaborative work. Other spaces work well for student work on projects as well as supporting spaces for specialized equipment for visualization.

Summary

The Computer Science and Engineering department at University of Hawaii at Hilo is in remarkably good shape at the moment despite the severe budget constraints that it is dealing with. The students seem quite happy with the program and curriculum, and appreciate the extra efforts of the faculty in supporting their involvement in national and international competitions. The department has a strong and demanding curriculum and the faculty I met seem very dedicated to supporting the students. Students and alums clearly feel very happy with their educations.

The main concerns for the department are the budget situation and finding a replacement for retiring instructor Barbara Meguro. It should not be a surprise that having a mechanism for upgrading and replacing computing equipment on a regular basis and buying software licenses is a necessity for a computer science department. This has become ever more important with the severed and disproportionate slashed in department budgets.

This report includes some suggestions for providing more flexibility in course requirements and for rethinking of the non-major courses supported by the department. Given the suggestions for rethinking and replacing the non-majors courses, it is important for the department to have a member who can take responsibility for these changes while supporting and guiding the various adjunct lecturers who teach many of these courses, a role currently performed by Meguro. While this could be handled by a tenure-track faculty member, a more appropriate person might be a long-term instructor, as it is not clear that a Ph.D. in computer science is necessary for taking charge of these primarily service courses. At any rate it is essential that someone be brought in take charge of these courses, their design, and supporting the faculty teaching them.

All in all, I came away from this study very impressed with the quality of education offered by the department, especially given the financial constraints. I hope solutions can be found to the budgetary problems and the replacement of Barbara Meguro so that the department can maintain the present high standards and effectiveness.

Finally, I would like to express my appreciation to the department, and especially chair Keith Edwards, for the hospitality shown me during my visit. I know how disruptive this can be in the midst of a busy semester.